

Characteristics of natural Japanese yew population in Muling Nature Reserve of Heilongjiang Province, China

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Abstract: The scalar of Japanese yew (*Taxus cuspidata*) population and the relationship between individual distribution and site factors were analyzed according to investigating data in 74 sample belts with a total sampled area of 436.872 hm² in Muling Nature Reserve. The result showed that the distribution rules of Japanese yew population were correlated to elevation, slope position, slope aspect and slope gradient. The optimal distribution range in elevation for the natural Japanese yew population is at the attitudes of 700–800 m. The amounts of Japanese yew individuals on shady slope were more than those on sunny slope. On top slope and mid-slope, the individual amounts of Japanese yew are more than those on toe slope. Most of Japanese yew individuals occurred on slope gradient of less than 15. The scalar of the population was decreased with the slope gradient increasing.

Keywords: Japanese yew; *Taxus cuspidata*; Muling Nature Reserve; Population

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Introduction

The Japanese yew (*Taxus cuspidata* Sieb. et. Zucc.) is a survivor tertiary species and the national level endangered species. The distribution area range of Japanese yew is divided into two parts: Eurasia and adjacent islands (E 123°–155°, N 32°30′–53°), with the altitude ranging from 250 m to 1200 m. The Eurasia distribution part includes Heilongjiang, Jilin and Liaoning provinces of China, north part of Korea, and border land of Russia. The distribution part of adjacent islands includes Sakhalin of Russia, Kyushu, Honshu, Hokkaido and Shikoku of Japan, and Jeju of South Korea. In China the Japanese yew concentrate mainly in Benxi, Hengren and Kuandian counties of Liaoning Province; Changbai, Fusong, Jingyu, Linjiang, Dunhua, Helong, Wangqing, Antu and Hunchun counties of Jilin Province; and Muling, Suiyang and Suiling counties of Heilongjiang Province (Wu 1995)(Fig. 1).

Previous studies of yew species were mainly focused on the taxol content and extract technique (Wang *et al.* 1997; Russin *et al.* 1995; Shi *et al.* 2003), application (Gustafson *et al.* 2003; Jennewein *et al.* 2003) and planting (Wu *et al.* 1996; Cui *et al.* 2003; Gao *et al.* 2003; Weng *et al.* 2003). The population and community characters of *Taxus wallichiana* var. *mairei* and *Taxus baccata* were well reported (Li *et al.* 1999; Liao *et al.* 2002; Thomas *et al.* 2003). However, little is known concerning with the characteristics of Japanese yew population, although some studies have been conducted on the geographic distribution (Wu *et al.* 1995; Bai *et al.* 2002) and bloom and seed (Cheng 2001) of the species. In this study, the scalar of Japanese yew population and the relationship between the population distribution and site factors in Muling Nature Reserve were analyzed based on the investigation data of 74 sample belts. The result of this study

reveals the characteristics of natural population of Japanese yew and provides reference for study of the species

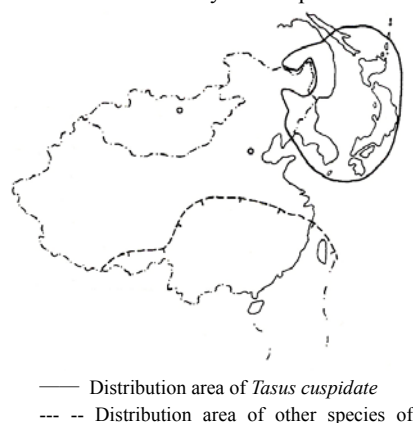


Fig. 1 Natural geographical distribution of *Taxus cuspidata*

Study area

The study was conducted in Muling Nature Reserve (E 130°–130°28′, N 43°49′–44°06′) with 33-km width, 31-km length, and total area of 34 544 hm², and located in the south of Heilongjiang Province. The landform of the reserve is composed of a vast area of low mountains with altitude of 500–900 m. The relative height is between 150 m and 450 m. Muling Nature Reserve belongs to humid and semi-humid regions of the monsoon temperate belt. The highest mean annual precipitation was recorded as 510 mm, and the lowest mean annual precipitation as 400 mm. The frost-free period is around 110 days. The annual average air temperature is -2°C. The zonal soil of the region is dark brown forest soil. The original vegetation is temperate mixed coniferous forest.

Methods

Selecting sample belt

According to the ecological characteristics of Japanese yew and the site factors of 156 compartments in Muling Nature Re-

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serve, 74 sample belts were chosen on sunny and shady slope (Table 1) and cover a total area of 436.872 hm². The sampled compartments are 49% on sunny slope and 45% on shady slope. Each sample belt included complete compartments, and the start and termination coordinate were fixed by using GPS (GARMIN-*etrex*).

Table 1. The number of compartments and samples

Locations	Compartment number		Sample belt number		Sampled compartment (%)	
	Shady slope	Sunny slope	Shady slope	Sunny slope	Shady slope	Sunny slope
Heping	53	39	25	15	47	38
Longzhaogou	20	10	8	3	40	30
Gonghe	21	10	12	8	57	80
Yangmuqiao	2	1	2	1	100	100
Sum	96	60	47	27	49	45

Data collection and analysis

The sampled Japanese yews were divided into seedling group (individual height < 1m), sapling group (1m ≤ individual height ≤ 5m) and tree group (individual height > 5m). The investigation data, such as the values of individual height, the diameter at breast height (DBH), geographical coordinate and site factors within each sample belt of 5-m width were recorded. Field investigation data were analyzed through the statistic software and the characteristic indexes, such as scalar and distribution, of natural Japanese yew population were obtained.

Results

The scalar of natural Japanese yew population

Of total 179 613 individuals of Japanese yew in the reserve, 127 416 individuals grow on the shady slope and 52 197 individuals on the sunny slope. The largest individual was 13 m in height and 92 cm in DBH. For all the 74 sample belts, Japanese yew individuals appeared in 49 sample belts (41 sample belts on shady slope and 8 sample belts on sunny slope), and no individual appeared in other 25 sample belts (14 sample belts on shady slope and 11 sample belts on sunny slope).

The saplings on both sunny and shady slope are pretty few. The trees on shady slope (0.7518 individuals·hm⁻²) are more than those on sunny slope (0.4924 individuals·hm⁻²) (Table 2). The individuals of less than 4 cm and those more than 16 cm in DBH account for 76.82% and 20.87% of the total scalar, respectively. And the individuals with DBH between 4 cm and 16 cm were only 2.32%.

The relationship between the distribution characteristics of natural Japanese yew population and the site factors

Population scalar and elevation

The 68.47% of sampled Japanese yews existed between the attitudes from 700 m to 800 m, 21.95% of the sampled individuals distributed at the attitude below 700 m, and 9.58% of the sampled individuals distributed over the attitude of 800 m (Table 3).

Most of Japanese yew seedlings distributed at the attitudes of 700–800 m and very few seedlings distributed at the attitudes of over 800 m. The sapling individuals were very less and are almost equivalent at different altitudes. For the tree group, the sampled individuals have notable rule following the change of altitude and slope. Most of tree individuals concentrated at the

altitude of 700–800 m.

Table 2. The statistic of natural Japanese yew population in Muling Nature Reserve

Items	Number of Japanese yew	Sample belt area (hm ²)	Individuals per hectare
Sunny slope	Seedling	118	27.418
	Sapling	0	27.418
	Tree	27	54.836
	Sum	145	109.672
Shady slope	Seedling	372	81.8
	Sapling	7	81.8
	Tree	123	163.6
	Sum	502	327.2
Total	647	436.872	8.4761

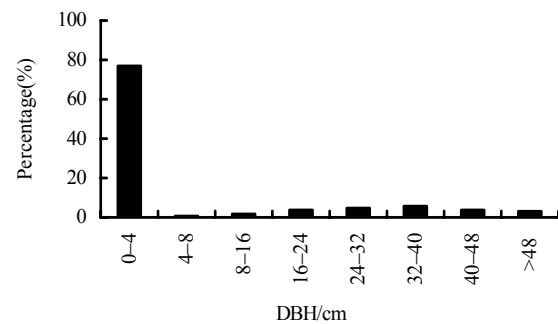


Fig.2 DBH distribution of Japanese yew population in Muling Nature Reserve

Table 3. Distribution of sampled Japanese yew at different elevations

Elevation (m)	Slope aspect	Group	Number of individuals	Average DBH (cm)	Average height (m)
≥800	Shady	Seedling	19	0.6	0.27
		Sapling	1	10	4
		Tree	21	40.85	11
	Sunny	Seedling	18	1.43	0.54
		Sapling	0	0	0
		Tree	3	28.7	11.5
700 – 800	Shady	Seedling	281	0.78	0.62
		Sapling	3	14	3.2
		Tree	68	36.46	11.6
	Sunny	Seedling	72	0.95	0.66
		Sapling	0	0	0
		Tree	19	32.32	11.68
<700	Shady	Seedling	81	0.83	0.54
		Sapling	3	4.67	2.33
		Tree	27	29.5	10.04
	Sunny	Seedling	27	1.41	0.83
		Sapling	0	0	0
		Tree	4	37.5	9.5

In Muling Nature Reserve, the optimal distribution range in elevation for the natural Japanese yew population is at the attitudes of 700–800 m, at the attitude less than 700 m or over 800 m, the number of living Japanese yew decrease obviously. Moreover, comparing with sunny slope, the shady slope is more suitable for the population of Japanese yew to enlarge.

Population scalar and slope position

The distribution characteristics of natural Japanese yew population are correlative to the factor of slope position through the

analysis on 647 sampled Japanese yew individuals (Table 4). More individuals occurred on mid-slope and top slope, and fewer on toe slope. With shady slope, the individuals on mid-slope and top slope amount to 97.61% of the total, and account to 84% on sunny slope.

Table 4. Distribution of Japanese yew on different slope positions

Slope position	Group	Sunny slope			Shady slope		
		Number of individuals	DBH (cm)	High (m)	Number of individuals	DBH (cm)	High (m)
Top slope	Seedling	60	0.83	0.44	101	0.60	0.92
	Sapling	0	0	0	3	4.67	2.33
	Tree	6	18.33	10	26	33.3	11.59
Mid slope	Seedling	39	1.72	1.05	269	0.73	0.59
	Sapling	0	0	0	4	12	3.37
	Tree	16	39	12.5	88	36.1	11.53
Toe slope	Seedling	19	0.88	0.71	9	0.9	0.65
	Sapling	0	0	0	0	0	0
	Tree	4	29	10.3	3	31.3	8

Population scalar and slope gradient

Slope gradient is confirmed as another restrictive site factor affecting the distribution of the natural Japanese yew population. Especially on the shady slope, number of natural Japanese yew individuals decrease with the increase of slope gradient (Fig. 3). For example, when the slope gradient is less than 10°, there are 236 sampled Japanese yew recorded. The number of individuals reduces to 200 when the slope gradient is between 10° and 15°, and the number decrease to 67 when the slope gradient is more than 15°.

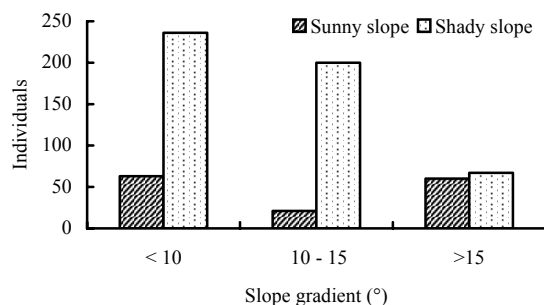


Fig.3 Scalar of Japanese yew Population at different gradient

Discussion

Although the scalar of natural Japanese yew population in Muling Nature Reserve is pretty large, the age structure of the natural population is not optimal. The number of seedlings and trees is much more than that of saplings. This kind of structure will affect the population development in the future.

Usually the Japanese yew appears as a concomitance species in the lower tree layer of Korean pine mixed forest (Chou 1986). Some studies showed that Japanese yew grew well when the relative humidity of environment was over 70% (Bai 2002). During the passing decades, the original forests lost gradually by cutting in Muling Nature Reserve that some Japanese yew individuals degenerated. Some trees of Japanese yew appeared when dead crown became withered partly or totally, and seed yield decreased. Therefore, improving the management and restoring the habitat of Japanese yew is one of the most critical tasks.

Biological characteristics lead Japanese yew to adverse situation in the competition with the other species. Owing to growing

in the shield site, the spread of Japanese yew seeds lost the effective natural power (e.g. wind), and the regenerations of the population distribute simply around the mother trees. Most individuals began to seed at age of 40–60 years, and the yield was low (Bai 2002). The slow growth is another negative property of Japanese yew to compete with other species. All of these factors affect Japanese yew population structure and restrict the population to enlarge.

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